

## Document de treball de l'IEB 2014/20

THE CAUSAL FACTORS OF INTERNATIONAL INEQUALITY IN CO<sub>2</sub> EMISSIONS  
PER CAPITA: A REGRESSION-BASED INEQUALITY DECOMPOSITION ANALYSIS

**Juan Antonio Duro, Jordi Teixidó-Figueras, Emilio Padilla**

**Energy Sustainability**

Document de  
treball de l'IEB

**THE CAUSAL FACTORS OF INTERNATIONAL INEQUALITY  
IN CO2 EMISSIONS PER CAPITA: A REGRESSION-BASED  
INEQUALITY DECOMPOSITION ANALYSIS**

Juan Antonio Duro, Jordi Teixidó-Figueras, Emilio Padilla

The **Barcelona Institute of Economics (IEB)** is a research centre at the University of Barcelona (UB) which specializes in the field of applied economics. The **IEB** is a foundation funded by the following institutions: Applus, Abertis, Ajuntament de Barcelona, Diputació de Barcelona, Gas Natural and La Caixa.

Within the IEB framework, the **Chair of Energy Sustainability** promotes research into the production, supply and use of the energy needed to maintain social welfare and development, placing special emphasis on economic, environmental and social aspects. There are three main research areas of interest within the program: energy sustainability, competition and consumers, and energy firms. The energy sustainability research area covers topics as energy efficiency, CO2 capture and storage, R+D in energy, green certificate markets, smart grids and meters, green energy and biofuels. The competition and consumers area is oriented to research on wholesale markets, retail markets, regulation, competition and consumers. The research area on energy firms is devoted to the analysis of business strategies, social and corporate responsibility, and industrial organization. Disseminating research outputs to a broad audience is an important objective of the program, whose results must be relevant both at national and international level.

The **Chair of Energy Sustainability of the University of Barcelona-IEB** is funded by the following enterprises ACS, CEPSA, CLH, Enagas, Endesa, FCC Energia, HC Energia, Gas Natural Fenosa, and Repsol) through FUNSEAM (Foundation for Energy and Environmental Sustainability).

Postal Address:

Chair in Energy Sustainability  
Institut d'Economia de Barcelona  
Facultat d'Economia i Empresa  
Universitat de Barcelona  
C/ Tinent Coronel Valenzuela, 1-11  
(08034) Barcelona, Spain  
Tel.: + 34 93 403 46 46  
Fax: + 34 93 403 98 32  
[ieb@ub.edu](mailto:ieb@ub.edu)  
<http://www.ieb.ub.edu>

The IEB working papers represent ongoing research that is circulated to encourage discussion and has not undergone a peer review process. Any opinions expressed here are those of the author(s) and not those of IEB.

**THE CAUSAL FACTORS OF INTERNATIONAL INEQUALITY  
IN CO2 EMISSIONS PER CAPITA: A REGRESSION-BASED  
INEQUALITY DECOMPOSITION ANALYSIS**

Juan Antonio Duro, Jordi Teixidó-Figueras, Emilio Padilla

**ABSTRACT:** This paper uses the possibilities provided by the regression-based inequality decomposition (Fields, 2003) to explore the contribution of different explanatory factors to international inequality in CO2 emissions per capita. In contrast to previous emissions inequality decompositions, which were based on identity relationships (Duro and Padilla, 2006), this methodology does not impose any a priori specific relationship. Thus, it allows an assessment of the contribution to inequality of different relevant variables. In short, the paper appraises the relative contributions of affluence, sectoral composition, demographic factors and climate. The analysis is applied to selected years of the period 1993–2007. The results show the important (though decreasing) share of the contribution of demographic factors, as well as a significant contribution of affluence and sectoral composition..

JEL Codes: C19, D39, Q43

Keywords: CO2 emissions, international emissions inequality, regression-based decomposition

Juan Antonio Duro  
Departament d'Economia and  
CREIP  
Universitat Rovira i Virgili  
43204 Reus, Spain  
E-mail: [juanantonio.duro@urv.cat](mailto:juanantonio.duro@urv.cat)

Jordi Teixidó-Figueras  
Departament d'Economia and  
CREIP  
Universitat Rovira i Virgili  
43204 Reus, Spain  
E-mail: [jordijosep.teixido@urv.cat](mailto:jordijosep.teixido@urv.cat)

Emilio Padilla  
Department of Applied  
Economics  
Univ. Autònoma de Barcelona  
Campus de Bellaterra  
08193 Cerdanyola del Vallès,  
Spain  
E-mail: [emilio.padilla@uab.es](mailto:emilio.padilla@uab.es)

## **1. Introduction**

There is a huge inequality in the international distribution of CO<sub>2</sub> emissions. Differences in emissions per capita and in their determinants lead to different perceptions of and interests in the criteria to distribute abatement efforts among countries—and even of the ambition of mitigation goals—and so hamper mitigation agreements. A correct design of policies should appropriately take into account these inequalities, which show different responsibilities for the problem, as well as the different drivers of them. A wider participation in international abatement agreements on the part of developing and emerging economies would be facilitated by the perceived fairness of abatement sharing. This perceived fairness will increase if countries with greater responsibility in the problem are charged with the most important part of mitigation efforts. Agreements, as the past ones, assuming a very uneven distribution of the CO<sub>2</sub> absorption capacity in the atmosphere and not involving strong efforts by the main countries responsible for causing the problem would tend to disincentivise the participation of developing countries. These countries claim that the global sink capacity is being disproportionately appropriated by the inhabitants of richer countries, which are also responsible for past overuse leading to the intensification of the greenhouse effect resulting in accelerated global warming. On the other hand, the greater the degree of inequality, the more reluctant the main emitters may be to participate in agreements asking them to assume most of the burden of emissions reduction.

Disparities in emissions per capita are due to factors that follow different paths in different countries. A good knowledge both of the evolution of inequality and of the drivers of the differences in emissions per capita and their trajectories over time is essential to inform the debates on policy design and on the criteria to distribute abatement efforts. The conclusions both for analysing the feasibility of agreements of a given situation and for informing policy design would be quite different depending on the different contributions of the relevant factors to emissions inequality.

The increase in papers in recent years dealing with the international distribution of CO<sub>2</sub> emissions is noticeable. These analyses have followed two complementary paths. First, several works employ the methodologies developed in the literature on the measurement of income inequality (some of the reference works include Atkinson, 1970; Sen, 1973; and Cowell, 2011). These focus on aspects such as the properties of the measurements and their factorial decomposition. The application and adaptation of this literature to the analysis of environmental indicators extend the analysis made in the field of income distribution. Some references in this line include Heil and Wodon (1997, 2000), Alcántara and Duro (2004), Hedenus and Azar (2005), Duro and Padilla (2006), Padilla and Serrano (2006), Cantore and Padilla (2010), Cantore (2011) and Duro (2012). Second, there are a series of works also analysing the international distribution of CO<sub>2</sub> (and other environmental indicators), but by means of the methods developed in the literature on economic growth and convergence (Barro and Sala i Martín, 1991; Quah, 1995). Some examples of these works are Strazicich and List (2003), Nguyen Van (2005), Aldy (2006), Ezcurra (2007), Romero-Ávila (2008), Criado and Grether (2010), Jobert et al. (2010) and Barassi et al. (2011). Both lines of research analyse similar issues with different tools and coincide in the relevance of measuring emissions disparities as a tool for helping policy design.

Such proliferation of distributive analyses applied to the international distribution of CO<sub>2</sub> per capita might be seen as the result of the awareness of ecological limits as well as of the need to inform discussions on the different responsibilities and on the mitigation efforts to be assumed by different countries. Moreover, this research complements the abundant literature focused on the study of the driving forces of CO<sub>2</sub> emissions (Grossman, 1993; Stern et al., 1996; Suri and Chapman, 1998; Torras and Boyce, 1998; York et al., 2003; Sharma, 2011). Among them, affluence, population, technology (the factors of the so-called IPAT identity proposed by Ehrlich and Holdren, 1971),<sup>1</sup> economic

---

<sup>1</sup> York et al. (2003) turned that accounting equation into a stochastic regression model, allowing them to make a test hypothesis and also to introduce further determinants of the environmental impact.

structure, demographic characteristics and climate characteristics are usually considered among the main drivers of environmental impacts. These analyses usually consist of econometric models whose emphasis is on the regression coefficients and their significance. However, as far as we know, the contribution of these factors to emissions inequality measures has not yet been explicitly and precisely approached. In this sense, a relevant methodological basis to approach such analysis is the regression-based inequality decomposition approach (RBID hereafter), which allows the development of such analysis without being constrained to an automatic accounting relationship between explanatory factors and emissions. Actually, previous analyses decomposing emissions per capita inequality have taken as reference multiplicative identities and group decompositions (Duro and Padilla, 2006). In contrast, the RBID technique allows one to widen the list of explanatory factors unrestrictedly.

The method proposed consists of, first, running an auxiliary econometric estimation to derive an additive decomposition of CO<sub>2</sub> emissions per capita. The model we will employ as reference for the identification of determinant factors may be seen as an extended version of the econometric models usually employed to test the environmental Kuznets curve hypothesis or the STIRPAT models. In short, it includes as explanatory factors affluence, demographic factors, sectoral composition and a climate variable. Second, the model applies the methods of additive decomposition of inequality (Shorrocks, 1982, 1983) to determine factorial contributions. Therefore, from a methodological point of view, the proposed technique merges two hot research topics: the analysis of inequalities in the contribution to climate change and the econometric estimation of impact driving forces. The contribution of such factors to global emissions inequality depends on two basic parameters: the average direct relationship between the examined factor and countries' CO<sub>2</sub> per capita (i.e. coefficient-effect), and the relative magnitude of the international variation of the factor (i.e. dispersion effect). The methodology is applied to the analysis of international inequality in CO<sub>2</sub> emissions per capita for the period 1993–2007.

Our analysis will contribute, first, to informing how the evolution of disparities leads or does not lead to a situation in which it is more likely that countries share interests and perceptions of how to distribute abatement efforts; second, it will contribute to the analysis of the determinants of emissions and how they change over time; and third, it will show the factors behind the trajectory of inequality. These factors should be adequately taken into account for a proper design of policies that facilitate wider and fairer agreements.

The remainder of this paper is organised as follows. Section 2 describes the RBID methodology. Section 3 measures the international inequality in CO<sub>2</sub> emissions per capita and presents the results of the estimation of the driving forces of emissions and their contribution to the international inequality of CO<sub>2</sub> emissions per capita according to the proposed methodology. Section 4 concludes the paper.

## **2. The regression-based inequality decomposition: methodological aspects**

Inequality decomposition methods allow one to quantify which part of total inequality is attributable to different components. The traditional additive decomposition approach (Shorrocks, 1982) allows to one break down the inequality of any variable according to its additive components. Additionally, such an approach has been extended to decomposition into multiplicative factors by taking advantage of logarithmic inequality measures such as the Theil index. These methods require a consistent identity in order to perform the decomposition.<sup>2</sup> Therefore, the main restriction is that the contributions to inequality considered are limited to the components of the mathematical identity.

---

<sup>2</sup> These analytical decomposition methods have been applied to ecological footprint in White (2007), Teixido-Figueras and Duro (2012) and Duro and Teixidó-Figueras (2012). For the case of CO<sub>2</sub> emissions, Duro and Padilla (2006) made a multiplicative decomposition of the contribution of Kaya (1989) factors.

In contrast, the RBID approach allows one not only to account for the contribution to inequality of different components, but also to undertake causal analysis since the contributions to inequality are attributed to the explanatory variables of an econometric model. Therefore, the model can incorporate any significant explanatory variable contributing to CO<sub>2</sub> emissions inequality.<sup>3</sup> The first step is to construct a linear regression function such as the ones typically used to estimate the driving forces elasticities of a given environmental pressure ( $E$ ):

$$E = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_K X_K + \varepsilon \quad (1)$$

Where  $E$  is the vector of the environmental pressure in the different countries considered and  $X_i$  ( $i=0, \dots, K$ ) the vectors for the driving forces or determinants of this pressure.

There is a vast empirical literature estimating such functions, such as is the case of the literature testing the environmental Kuznets Curve hypothesis (Grossman, 1993; Stern et al., 1996; Suri and Chapman, 1998; Torras and Boyce, 1998; Sharma 2011) or the stochastic regressions of relationships derived from the IPAT identity (STIRPAT) (York et al., 2003). Those empirical models try to disentangle the main determinants of environmental pressures or impacts analysing the significance of independent variables such as income, sectoral composition, population and demographic characteristics, among others, in some cases controlling also for different regional climate characteristics. Nonetheless, there is still no attempt to answer which is the contribution of each of these relevant variables to the international inequality in environmental indicators.

Expression (1) presents environmental pressure, in our case CO<sub>2</sub> emissions per capita, as the sum of  $K$  explanatory variables plus the constant and error terms. So, we can rearrange it and obtain:

---

<sup>3</sup> Most RBID applications analyse income inequality from a micro-approach, so there is an income-generating function, and income inequality is decomposed in terms of the typical explanatory variables of those models: race, education level, gender, age, etc. (e.g. Cowell and Fiorio, 2009; Fields, 2003; Gunatilaka and Chotikapanich, 2009; Morduch and Sicular, 2002; Wan, 2004).



$$E = \sum_{k=0}^{K+2} \beta_k X_k \quad (2)$$

The RBID is based on considering the product of the estimated coefficient  $\beta_k$  and its variable  $X_k$  as the “causal component” of CO<sub>2</sub> emissions per capita, where the coefficient plays the role of weighting the importance of component  $k$ . The explanatory variables jointly with the constant and the residual form a consistent identity as those required by traditional decomposition methods, so that the natural decomposition rule can be performed by sources (see Shorrocks, 1982; Fields, 2003).

Although there are other methods to decompose inequality using regression-based techniques, we use the Fields (2003) method because of its simplicity and analogy to natural source decomposition described.<sup>4</sup> In this RBID approach the functional form of the model is restricted to a semi-log linear function:<sup>5</sup>

$$\ln E = \sum_{k=0}^{K+2} \beta_k X_k \quad (3)$$

Once the semi-log model is estimated, the procedure continues by taking variances on both sides of the equation. Note that the variance of the logarithm of emissions per capita is a common inequality index (see Cowell, 2011):

$$\text{var}(\ln E) = \text{var}\left(\sum_{k=0}^{K+2} \beta_k X_k\right) \quad (4)$$

By rearranging the right hand side of expression (4), we obtain the variance of logarithms as a sum of the covariances between each causal component and the dependent variable (the logarithm of CO<sub>2</sub> emissions per capita):

---

<sup>4</sup> There are several empirical applications to income inequality comparing results obtained according to the different methods of RBID. Very often they conclude that there are no significant differences (Cowell and Fiorio, 2009; Fields, 2003; Gunatilaka and Chotikapanich, 2009; Morduch and Sicular, 2002; Wan, 2004).

<sup>5</sup> The semi-log model  $\ln(E) = \beta_0 + \beta_1 F_1 + \beta_2 F_2 + \dots + \beta_k F_k + \varepsilon_i$  is equivalent to  $E = \exp(\beta_0 + \beta_1 F_1 + \beta_2 F_2 + \dots + \beta_k F_k + \varepsilon_i) = \exp(\beta_0) \cdot \prod_{k=1}^k \exp(\beta_k F_k) \cdot \exp(\varepsilon_i)$ . Then, the contribution  $\beta_0$  is null since it is a constant to each observation.

$$\text{var}(\ln E) = \sum_{k=0}^{K+2} \text{cov}(\beta_k X_k, \ln E) \quad (5)$$

This result is highly convenient since in the inequality literature those covariances are the natural decomposition of the variance, which indeed is a consistent decomposition rule. Hence, in order to obtain the relative contribution of each causal component, we define:

$$s_k(\ln E) = \frac{\text{cov}[\beta_k X_k, \ln E]}{\text{var}(\ln E)} \quad (6)$$

being  $s_k$  the percentage contribution of factor  $k$  to the level of inequality observed.<sup>6</sup>

Since the coefficients of the regression play a weighting role, it may be interesting to know whether the different trajectories of  $s_k$  are caused by changes in the dispersion of factor  $k$ , or by changes in its importance in the function measured by  $\beta$ :

$$s_{kt} - s_{kt-1} = \frac{\text{cov}(Z_t^k, \ln E_t)}{\text{var}(\ln E_t)} - \frac{\text{cov}(Z_{t-1}^k, \ln E_{t-1})}{\text{var}(\ln E_{t-1})} = \left[ \frac{\text{cov}(\hat{Z}_{t-1}^k, \ln E_t)}{\text{var}(\ln E_t)} - \frac{\text{cov}(Z_{t-1}^k, \ln E_{t-1})}{\text{var}(\ln E_{t-1})} \right] + \left[ \frac{\text{cov}(Z_t^k, \ln E_t)}{\text{var}(\ln E_t)} - \frac{\text{cov}(\hat{Z}_{t-1}^k, \ln E_t)}{\text{var}(\ln E_t)} \right] \quad (7)$$

where  $Z_t^k = \beta_{kt} X_{kt}$  and  $\hat{Z}_{t-1}^k = \beta_{kt-1} X_{kt}$ . The first term of the right-hand side is the *dispersion effect* since the coefficients are not allowed to vary (and so only the dispersion changes between  $t - 1$  and  $t$ ). The second term is the *coefficient effect* since the dispersion of vector  $X_k$  is not allowed to vary (so only the coefficient changes between both periods).

---

<sup>6</sup> Independently of the index chosen by the researcher to assess inequality, the natural decomposition of the variance is the unique unambiguous rule given that it is the only decomposition rule that allocates indirect effects among components in a non-arbitrary way. In other words, the contribution of factor  $k$  is independent of the inequality index used (see Cowell, 2000; Shorrocks, 1982, 1983).

Additionally, we may be interested in knowing the contribution of factor  $k$  to the change in inequality level between two periods. That inequality change contribution is expressed as:

$$\delta_k \equiv \frac{s_{kt} I(.)_t - s_{kt-1} I(.)_{t-1}}{I(.)_t - I(.)_{t-1}} \quad (8)$$

where  $I(.)$  is the inequality measure for period  $t$ . Notice that expression (8) is not restricted to the use of any particular inequality index. Our choice for the empirical analysis will be neutral indexes such as  $GE(2)$  or  $CV$  (Duro, 2012).

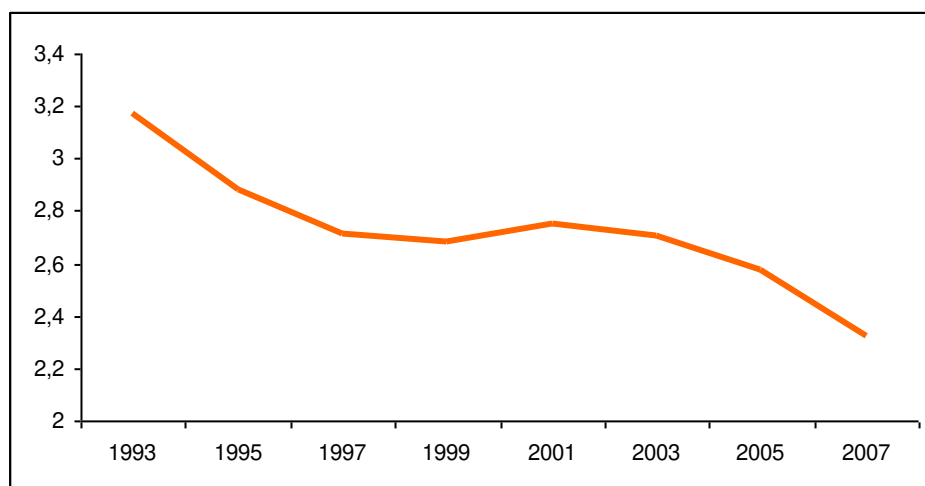
### **3. International inequality in CO<sub>2</sub> emissions per capita and explanatory factors**

As stated above, we use logarithmic variance as a reference index. This choice is associated to the RBID methodology employed, which, based on the work of Fields (2003), uses this measure for consistency. In any case, as we will later show, the factorial decomposition can be applied to any consistent inequality index. Logarithmic variance is a well-known measure that fulfils the scale-independent property (that is, is a relative measure) but does not fulfil the progressivity principle for high observations, which does not have a significant impact in our case (Cowell, 2011).

Our analysis covers the period from 1993 to 2007 by eight biannual cross-section samples. The data used for each year cover at least 92% of world CO<sub>2</sub> emissions, 95% of world population and 96% of world GDP. Although the samples may be different among years, the results are virtually equivalent with balanced data. This means the results with balanced data (all years with the same countries) do not show any significant differences with the results obtained with the non-balanced sample (where we take the maximum number of countries in each sample). This is because the countries that are not included in a specific sample represent a very little proportion of the world CO<sub>2</sub> emissions (and of the world population and GDP). The data used comes from the World Bank (2013).

Figure 1 shows the international dispersion of CO<sub>2</sub> emissions per capita for the period 1993–2007. Initially, it can be noted that in this period the total emissions increased 40% and the per capita emissions, 16.7%. Coinciding with this increase was a significant reduction in dispersion, with three different subperiods. In the first, from 1993–1997, there was an important reduction of inequality; in the second, 1997–2003, there was a stabilisation of inequality; and finally, in the third, 2003–2007, there was a new important reduction. Therefore, we may say that the international responsibility in CO<sub>2</sub> emissions, at least in per capita terms, is becoming more diffused.

**Figure 1. International inequality in CO<sub>2</sub> emissions per capita measured by log-variance**



Source: Produced by the authors based on World Bank (2013).

However, underlying such a trend different stories may be occurring. Are the major polluters reducing their emissions per capita, or, in contrast, are the minor polluters increasing their emissions? Or may it be both things? Observing the quantiles distribution in Table 1, the latter appears as more plausible since the first percentile per capita emissions increased 64%, while percentile 0.9 increased only 5%. Therefore, from the environmental point of view this reduction in inequality cannot be identified as good news as it was based on a greater increase in lower emitters and not on a reduction in major emitters.

Obviously, in the quantiles analysis there is the anonymity axiom, i.e. we may talk of different countries for the same quantiles in different years.

**Table 1. Distribution of countries (by quantiles) and changes in carbon emissions per capita, 1993–2007**

Quantiles q	1993	1999	2007	% Q- change 1993–1999	% Q- change 1999–2007	% Q- change 1993–2007
0.10	0.10	0.15	0.17	53%	8%	64%
0.20	0.29	0.38	0.43	31%	11%	46%
0.30	0.66	0.81	0.97	23%	20%	47%
0.40	1.14	1.22	1.58	6%	30%	38%
0.50	2.04	2.23	2.77	9%	24%	36%
0.60	3.58	3.92	4.57	10%	16%	28%
0.70	5.85	5.89	6.18	1%	5%	6%
0.80	7.48	7.91	8.06	6%	2%	8%
0.90	11.24	10.60	11.75	-6%	11%	5%

Source: Produced by the authors based on World Bank (2013).

Note: quantile refers to countries' percentage. So  $Q_{0.10}$  in 2007 means 10% of world countries had CO<sub>2</sub> emissions per capita below 0.17 t.

Decomposing the inequality in CO<sub>2</sub> emissions per capita according to its determinants will enlighten the analysis of the causes of this inequality, complementing previous accounting approaches. The dependent variable used in the model is the CO<sub>2</sub> emissions per capita of the different countries in log scale, while the independent variables are several of those that have been typically used in the estimation of the determinants of environmental impacts or pressures (such as in the above cited STIRPAT models and the extended models used to test the environmental Kuznets curve). The data used come from the World Bank (2013). Table 2 details the descriptive statistics of the variables used in the model.

**Table 2. Descriptive statistics of explanatory factors**

<b>Variable (1993)</b>	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>CV</b>	<b>Min</b>	<b>Max</b>
CO2 emissions (ktonnes per capita)	189	4,739.77	7,031.45	1.48	1.69	62,517.04
ln (CO2 emissions per capita)	189	7.35	1.83		0.53	11.04
per capita GDP (constant 2000 US\$)	187	6,423.19	10,135.28	1.58	79.58	68,695.23
Agriculture GDP share (%)	165	19.43	16.23	0.83	-	65.12
Industrial GDP share (%)	166	29.02	10.98	0.38	8.70	64.00
Urban population share (%)	210	52.82	24.67	0.47	6.84	100.00
Non dependent population share (aged 15 to 65)	190	59.08	6.71	0.11	45.53	72.13
Average daily min temperature	198	13.67	8.66	0.63	- 22.60	25.30

<b>Variable (1999)</b>	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>CV</b>	<b>Min</b>	<b>Max</b>
CO2 emissions (ktonnes per capita)	195	4,622.44	6,401.30	1.38	15.23	55,114.07
ln (CO2 emissions per capita)	195	7.46	1.66		2.72	10.92
per capita GDP (constant 2000 US\$)	196	7,511.32	11,999.97	1.60	95.50	74,111.49
Agriculture GDP share (%)	171	17.41	15.61	0.90	-	76.19
Industrial GDP share (%)	172	28.78	11.96	0.42	7.20	79.99
Urban population share(%)	210	54.58	24.55	0.45	8.08	100.00
Non dependent population share (aged 15 to 65)	190	60.41	6.52	0.11	48.14	72.74
Average daily min temperature	198	13.67	8.66	0.63	- 22.60	25.30

<b>Variable (2007)</b>	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>CV</b>	<b>Min</b>	<b>Max</b>
CO2 emissions (ktonnes per capita)	198	5,096.36	6,849.85	1.34	22.61	57,660.25
ln (CO2 emissions per capita)	198	7.58	1.66		3.12	10.96
per capita GDP (constant 2000 US\$)	194	9,191.87	14,631.59	1.59	96.25	98,397.09
Agriculture GDP share (%)	169	12.53	12.28	0.98	-	54.99
Industrial GDP share (%)	171	31.11	14.10	0.45	5.86	94.58
Urban population share(%)	210	56.99	24.16	0.42	10.10	100.00
Non dependent population share (aged 15 to 65)	190	62.94	6.87	0.11	48.81	82.22
Average daily min temperature	198	13.67	8.66	0.63	- 22.60	25.30

Source: Produced by the authors based on World Bank (2013).

Note: further descriptive data is available upon request. The most recent available climate standard normal has been used as climatic reference of the country.

The results obtained when applying the RBID methodology are twofold. First, we obtain the regression results of the estimation of the determinants of CO<sub>2</sub> emissions per capita. Second, using the regression results we estimate the contributions of the explanatory variables to the international inequality in CO<sub>2</sub> emissions per capita by using expression (6) of the previous section. The OLS results (i.e. auxiliary regressions) are presented in Table 3. The model estimated explains close to 85% of the cross-national log-variance in CO<sub>2</sub> emissions per capita (except for 1993, in which it explains around 80%),

indicating that used variables provide a good fit. The significance and the sign of the coefficients obtained are coherent with the empirical literature dealing with the determinants of CO<sub>2</sub> emissions. Besides, this high significance points out that multicollinearity may not be a very important problem. Indeed, we calculated quadratic partial correlations between the exogenous variables and the dependent variable, and the low values obtained indicate that multicollinearity is not a substantial problem in our estimation.<sup>7</sup>

Since it is a semi-log model, we must interpret the significant coefficients as semi-elasticities, i.e. an increase (decrease) of one unit in the explanatory variable yields a  $\beta\%$  increase (decrease) in the dependent variable. Hence, focusing on 2007 coefficients, an increase in one dollar of GDP per capita yields a 0.01% increase of CO<sub>2</sub> emissions per capita, while an increase in the climate normal minimum temperature would yield a -2.10% decrease in emissions per capita, and so on.

We are estimating cross-national determinants and so are not making assumptions about the individual behaviour of countries over time. A wrong assumption often made in the environmental Kuznets curve literature, when making panel data estimations, is to assume the same functional form and parameters for each country in their relationship between income (and other variables) and environmental pressure (or impact) over time. This assumption has been clearly rejected when appropriately tested (see Perman and Stern, 1999 and 2003; List and Gallet, 1999; Dijkgraaf and Vollenberg, 2005; Martínez-Zarzoso and Bengochea-Morancho, 2003 and 2004; Piaggio and Padilla, 2012). Thus, our results just show cross-national relationships between independent variables that change across countries and CO<sub>2</sub> emissions per capita in a given moment of time. These relationships may be caused by different underlying reasons (levels of development, international specialisation,

---

<sup>7</sup> As a robustness check, other models have been estimated with different regressors than those in Table 3. Results obtained were virtually equivalent. As can be expected the higher correlations belong to cubic and quadratic terms of GDP per capita; however, it must be taken into account that the non-collinearity assumption is about linear relationships among regressors, and despite its high correlation with linear GDP per capita, the cubic and quadratic terms are a non-linear relationship. Hence, it does not violate the basic assumption (Gujarati and Porter, 2009).

different regulations, etc.) and be the result of different patterns followed by different countries, as the literature seems to support.

Affluence variables indicate the existence of a non-monotonic relationship since both quadratic and cubic GDP per capita variables are significant. This shows an N-shape cross-national pattern (Friedl and Getzner, 2003; Sengupta, 1996; Taskin and Zaim, 2000), though with a basic increasing segment and small coefficients for quadratic and cubic terms, and so the environmental Kuznets curve hypothesis is not supported by the data. Therefore, it may be stated that in most cases greater affluence is accompanied by greater CO<sub>2</sub> emissions per capita.

Attending to sectoral composition determinants, a priori, a greater weight of industrial sectors is expected to be associated with greater emissions, while those economies with greater weight of services, and specifically of knowledge-based technology-intensive industries, are expected to have lower emissions than those based on energy intensive industry (Dinda, 2004). In any case, it should be taken into account that several services also make an intensive use of energy (Suh, 2006; Alcántara and Padilla, 2009), and the idea that services are immaterial sectors should be dismissed. Sectoral composition coefficients—industrial GDP share and agricultural GDP share—show the expected values. A positive coefficient of industrial share must be interpreted as the CO<sub>2</sub> emissions percentage augmented when the share of the sector increases 1% and the base sector (services) decreases in this same percentage. In contrast, the agricultural share coefficient shows a CO<sub>2</sub> emissions per capita comparative decrease.

Demographic variables have positive significant coefficients, indicating their influence in spurring emissions per capita. The non-dependent population (aged 15–65), which captures the most consumerist and productive segment of the population, exhibits an important role in driving emissions: a 1% increase represents a cross-national increase of 8–10% in CO<sub>2</sub> emissions per capita. This suggests that population age structure may play a significant role in explaining differences in emissions. This contrasts with previous results in the literature, such as Dietz et al. (2003) for the case of the ecological footprint and



Cole and Neumayer (2004) for the case of total CO<sub>2</sub> emissions, who did not find significant coefficients for age distribution. Some differences with the study of Cole and Neumayer (2004) that may explain the different result is the use of per capita instead of total emissions, as well as the set of variables included our model.

Urban population share exhibits a lower effect but is still significant and positive, except for years 2001 and 2007 when the estimated coefficient is not significant. Our estimates are consistent with the previous evidence in the literature (see Parikh and Shukla, 1995, for the evidence on developing countries; and Cole and Neumayer, 2004, for an international cross-section sample including developing and developed countries). We find, however, that the coefficient decreases over time. The positive impact of urbanisation on emissions stems from the fact that an urban lifestyle and facilities lead people to consume more energy and thus generate more CO<sub>2</sub> emissions in urban areas than in rural ones, especially in developing countries, which represent the biggest part of the world. The migration of rural workers to urban areas in search of better jobs tends to yield a sprawl growth of cities with large suburbs and the need to commute every day by private vehicle. There is also more use of fossil fuels instead of fuel wood and longer distances travelled for the provision of food and other products (Jones, 1989; Parikh and Shukla, 1995). Moreover, the use of public and private motor vehicles—cars, buses, and motorcycles—is likely to be more extended in urban than in rural areas (Cole and Neumayer, 2003). However, the impacts of urbanisation on emissions are of a different type, and although most studies indicate that urbanisation tends to increase energy consumption and emissions due to the abovementioned reasons, there are other impacts that may go in the opposite way as urbanisation may be accompanied by greater access to information, technical innovation and efficient land and energy use, which may contribute to the reduction of energy consumption and emissions in the long run (Jiang et al., 2008; Jiang and Hardee, 2011). Actually, there are mixed results on the impact of urbanisation on energy consumption and emissions (Jiang and Hardee, 2011). The decreasing coefficient of the variable may indicate that some of the

gains associated with urbanisation may now be more effectively compensating the negative effects.

Both demographic variables, jointly with others like household size (Liu et al., 2003) have only been studied to a limited extent in the literature but are projected to have quite an important impact on the future evolution of emissions (Jiang and Hardee, 2011).

Lastly, the climate control variable, proxied by the climate normal<sup>8</sup> of minimum temperature, indicates that an increase in normal temperatures of 1 °C would decrease CO<sub>2</sub> emissions per capita approximately 2%. This result shows the fact that colder climates require greater amounts of energy for heating and lower for cooling, the first impact being more important. Previous studies, such as Neumayer (2004), also found that a cold climate is significantly associated with greater CO<sub>2</sub> emissions.

---

<sup>8</sup> Climatologists define a climatic normal as the arithmetic average of a climate element (such as temperature) over a prescribed 30-year interval in order to filter out many of the short-term fluctuations and other anomalies that are not truly representational of the real climate. The last climatic normal available is for the period 1971–2000

**Table 3. Results from auxiliary OLS regressions on CO<sub>2</sub> per capita and explanatory factors, 1993–2007**

Variable	1993	1995	1997	1999	2001	2003	2005	2007
<b>Affluence</b>								
GDP per capita	.00022778**	.00021738***	.00015367**	.00015564***	.00015664***	.00016302***	.00016393***	.00016841***
Squared GDP per capita	-1.431e-08**	-1.322e-08***	-8.516e-09**	-8.346e-09**	-7.730e-09***	-7.707e-09***	-7.461e-09***	-7.006e-09***
Cubic GDP per capita	2.497e-13**	2.243e-13**	1.346e-13*	1.278e-13**	1.116e-13***	1.087e-13***	9.962e-14***	8.448e-14***
<b>Sectoral Composition</b>								
Agric. GDP share (%)	-.01342054*	-.02222722***	-.02916964***	-.02927415***	-.02897955***	-.02527107***	-.02486403***	-.03068516***
Indust. GDP share (%)	.0347483***	.03459411***	.02564298***	.018115***	.02332022***	.02433404***	.01680331***	.01653982***
<b>Population Structure</b>								
Urban population share	.01733784***	.01225186***	.00822251**	.00671887*	0.00546392	.00571538*	.00623419*	0.00337771
Non-dependent pop.	.07808158***	.06992016***	.08566869***	.09595006***	.10306478***	.10293884***	.10317962***	.08912037***
<b>Climate</b>								
Av. daily min. temp.	-.02463132**	-.02426302***	-.02362798***	-.02221845***	-.01600683**	-.01564607**	-.01747623**	-.02104922***
<b>Constant</b>	0.9419073	1.8809878**	1.5956777*	1.1516657	0.42887263	0.23336353	0.31073141	1.3898487*
Countries <sup>1</sup>	154	161	161	160	163	165	161	155
Squared R	0.79798729	0.84017732	0.85189569	0.84314694	0.85502122	0.8497542	0.84449959	0.84741744
Adjusted Squared R	0.78684176	0.8317656	0.84410073	0.83483684	0.84748985	0.84204928	0.83631536	0.83905675
log-likelihood	-183.69907	-165.53358	-154.45728	-157.2094	-155.9453	-159.37318	-154.28651	-138.8818

Note: \* p<.1; \*\* p<.05; \*\*\* p<.01

Source: Produced by the authors based on World Bank (2013).

The regression results are used to calculate each factor's weight, which jointly with variable vector dispersion will yield the contributions to per capita CO<sub>2</sub> emissions inequality observed. Table 4 presents the relative factor contributions to inequality (expression 6).

**Table 4. Relative factor contribution to inequality in CO<sub>2</sub> per capita**

<b>Factors</b>	<b>1993</b>	<b>1995</b>	<b>1997</b>	<b>1999</b>	<b>2001</b>	<b>2003</b>	<b>2005</b>	<b>2007</b>
<b>Affluence</b>	<b>14.87</b>	<b>15.91</b>	<b>13.13</b>	<b>13.95</b>	<b>15.84</b>	<b>17.84</b>	<b>18.71</b>	<b>21.44</b>
<b>Sectoral Composition</b>	<b>19.72</b>	<b>28.71</b>	<b>30.85</b>	<b>27.54</b>	<b>27.70</b>	<b>24.66</b>	<b>21.05</b>	<b>24.36</b>
agriculture GDP share	8.86	16.66	22.38	22.30	20.74	17.47	16.64	19.80
Industrial GDP share	10.86	12.05	8.47	5.24	6.96	7.19	4.42	4.55
<b>Population Structure</b>	<b>39.67</b>	<b>34.05</b>	<b>35.68</b>	<b>37.51</b>	<b>38.53</b>	<b>39.14</b>	<b>40.64</b>	<b>33.88</b>
Urban pop. Share	17.39	12.99	8.76	7.00	5.51	5.65	6.11	3.24
Non-dependent pop.	22.27	21.05	26.92	30.51	33.02	33.49	34.54	30.64
<b>Climate</b>	<b>5.55</b>	<b>5.35</b>	<b>5.54</b>	<b>5.31</b>	<b>3.44</b>	<b>3.33</b>	<b>4.04</b>	<b>5.06</b>
<b>Residual</b>	<b>20.20</b>	<b>15.98</b>	<b>14.81</b>	<b>15.69</b>	<b>14.50</b>	<b>15.02</b>	<b>15.55</b>	<b>15.26</b>
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

Source: Produced by the authors based on World Bank (2013).

The affluence factor—which groups the GDP per capita variables—increased its contribution significantly to emissions inequality, reaching its largest share in 2007 with 21%.<sup>9</sup> Table 5 decomposes the change in this relative contribution of each factor into the two basic elements explaining it according to equation (7). Thus, these changes could be explained by a dispersion-effect—and so by changes in the weight of the international variability of the factor—by changes in the direct relationship between the factor and CO<sub>2</sub> emissions per capita

---

<sup>9</sup> This weight is clearly lower than the obtained by Duro and Padilla (2006) with a different methodology. Their study decomposed per capita CO<sub>2</sub> emissions inequality by a multiplicative identity (Kaya factors) using the Theil index. As a result, they obtained an affluence net contribution close to 60%, being the main contributor to CO<sub>2</sub> inequality. However, this difference can be explained by some methodological factors. First, the Kaya identity used in Duro and Padilla (2006) assumes elasticity proportionality by construction, while in our regression model the elasticities are allowed to vary among factors (see York et al., 2003). Second, the affluence contribution is more precisely defined and isolated in our paper, given the more detailed list of potential factors. Their study can therefore be gathering effects that in our case are separated, such as the ones associated with demographic and structure factors.

according to auxiliary regressions (Table 3), or by both. Taking the whole period, in which the relative contribution of this factor to the international inequality in CO<sub>2</sub> emissions per capita increases by 6.5%, the result is explained by the relative increase in the dispersion component of this variable.

Sectoral factors represent 24.4% of total inequalities, ranging between 19.7% in 1993 to 30.9% in 1997. In any case, the two factors change in different directions: there is a significant decrease in the importance of the industrial share and a relevant increase in the role of the agricultural share. While in 1993 the agricultural GDP share made a lower contribution than the industrial one, both contributions being of similar weight (8.9% and 10.9%, respectively), the relative relevance of both factors reverse, and for the last year considered the contribution to inequality of the agricultural share is more than four times the one of the industrial share (19.8% and 4.6%, respectively). It is remarkable that the increase in the importance of the agricultural share to explain CO<sub>2</sub> emissions differences, which is concentrated in the period 1993–1997, is mainly given by a coefficient effect (Table 5). Thus, its explanatory power in the regression increased significantly while its coefficient became more negative. That is, a greater share of agriculture—and so lower of services—is increasingly associated with lower relative emissions. This different sectoral structure has increased its relative contribution to emissions inequality, given the small importance of the dispersion component. This may be seen as support for the rejection of the notion of service economies as immaterial economies, as the service sector includes activities which require great use of energy, both directly—such as transport services—as well as indirectly—such as hotels and restaurants (Suh, 2006; Nansai et al., 2007; Alcántara and Padilla, 2009; Fourcroy et al., 2012). Moreover, some of these high-polluting service activities have experienced an important development in the last decades.

According to our results, demographic characteristics play the most important role in explaining inequality in CO<sub>2</sub> emissions per capita, accounting for 34% of it. In the first years of the sample the urbanisation variable contributed as much to inequality as the non-dependent population variable, 17.4% and 22.3%, respectively. Nonetheless, the relative contribution of urbanisation reduced its

level to a much lower value (3.2%). In contrast, non-dependent population increased its relative contribution over the period. In 2007 it explains 30% of international inequality in CO<sub>2</sub> emissions per capita. The reduction in the relative contribution of the urbanisation variable, which mainly occurred between 1993 and 1997, is largely attributable to the coefficient effect. As shown in Table 3, the positive relationship between urbanisation and greater CO<sub>2</sub> per capita decreases until being non-significantly different from zero in 2007. The decreasing importance in explaining global inequality—jointly with an important reduction in inequality levels—means that some of the abovementioned gains associated with urbanisation may now be more effectively compensating the dominant negative effects.

In contrast, the relative contribution of the age structure of population has increased, and the share of non-dependent population becomes the main explanatory factor of inequality. In this case, both parameters have contributed to this relative change, both the dispersion component (relative increase in the international dispersion in this variable) and the coefficient effect, for the clear increase in the relationship between non-dependent population share and emissions per capita, which increases from 0.078 to 0.089. The increase in the dispersion effect is due to the stability in the international dispersion of this variable in front of the decrease in the dispersion of the logarithm of emissions per capita. As regards the intensification of CO<sub>2</sub> emissions associated to non-dependent population, it seems clear that its greater mobility and energy intensive consumption holds over time as a driver explaining differences between countries.

The contribution of climate variable is quite stable over time, and explains only 5% of the differences in CO<sub>2</sub> emissions per capita. A direct conclusion is that international differences in CO<sub>2</sub> emissions per capita are mainly caused by anthropogenic CO<sub>2</sub> drivers.

Last, the residual contribution, which plays a significant role, needs a previous comment. In the typical applications of the STIRPAT models, T of Technology is estimated in the residual term rather than separately (see York et al., 2003). Therefore, we may interpret that the residual could show in part a technological

effect where the resources are more efficiently used, though it may also be showing the impact of other omitted variables. Consequently, international spillovers may be occurring in benefit of more equitable per capita emissions. Such greater efficiency may be spurred on by either private gains in resource saving or environmental policy regulations. The contribution of this residual to total inequality in CO<sub>2</sub> emissions per capita was quite stable, around 15% after its decline in first years.

**Table 5. Decomposition of the contribution of each factor to inequality changes into coefficient and dispersion effects**

	<b>Contrib. Change</b>	<b>Dispersion effect</b>	<b>Coefficient effect</b>		
<b>1993–1997</b>					
Affluence	-0.0173	0.0199	-115%	-0.0371	215%
Agriculture GDP share (%)	0.1343	0.0143	11%	0.1201	89%
Industrial GDP share (%)	-0.0236	0.0063	-26%	-0.0299	126%
Non-dependent population share (aged 15 to 65)	0.0462	0.0225	49%	0.0237	51%
Urban population share (%)	-0.0858	0.0107	-12%	-0.0965	112%
Average daily min. temperature	-0.0001	0.0023	-3887%	-0.0023	3987%
Residual	-0.0538	-0.0538	100%	0.0000	0%
<b>1997–2003</b>					
Affluence	0.046	0.011	24%	0.035	76%
Agriculture GDP share (%)	-0.049	-0.022	45%	-0.027	55%
Industrial GDP share (%)	-0.013	-0.009	70%	-0.004	30%
Non dependent population share (aged 15 to 65)	0.065	0.010	15%	0.056	85%
Urban population share (%)	-0.031	-0.006	20%	-0.025	80%
Average daily min. temperature	-0.022	-0.024	111%	0.002	-11%
Residual	0.003	0.003	100%	0.000	0%
<b>2003–2007</b>					
Affluence	0.036	0.031	86%	0.005	14%
Agriculture GDP share (%)	0.023	-0.012	-50%	0.035	150%
Industrial GDP share (%)	-0.026	-0.005	19%	-0.021	81%
Non-dependent population share (aged 15 to 65)	-0.028	0.019	-66%	-0.047	166%
Urban population share (%)	-0.024	-0.002	7%	-0.022	93%
Average daily min. temperature	0.017	0.004	25%	0.013	75%
Residual	-0.005	-0.005	100%	0.0000	0%
<b>1993–2007</b>					
Affluence	0.0648	0.1267	195%	-0.0619	-95%
Agriculture GDP share (%)	0.1087	-0.0020	-2%	0.1107	102%
Industrial GDP share (%)	-0.0626	-0.0128	21%	-0.0498	79%
Non-dependent population share (aged 15 to 65)	0.0832	0.0455	55%	0.0377	45%
Urban population share (%)	-0.1406	-0.0075	5%	-0.1331	95%
Average daily min. temperature	-0.0048	0.0038	-79%	-0.0086	179%
Residual	-0.0487	-0.0487	100%	0.0000	0%

Source: Produced by the authors based on World Bank (2013).

Once we know the different relative contribution of factors to CO<sub>2</sub> inequality, it is interesting to analyse the contribution of those factors to inequality change over the period analysed (expression 8 above). As we saw in Figure 1, the inequality between countries in CO<sub>2</sub> emissions per capita has decreased in the period considered. Other studies also point in the same direction (Heil and Wodon, 2000; Duro and Padilla, 2006; Padilla and Serrano, 2006). In our period, the



reduction in inequality measured with log-variance was -18%. Table 6 presents the relative contribution of each factor to such inequality change. Those factors that are presented with a negative contribution change are the factors that have contributed to making the distribution of emissions more unequal. In contrast, those factors with a positive sign have contributed to a lower inequality in CO<sub>2</sub> emissions per capita. The main driver of the reduction in emissions inequality was urbanisation, which accounts for 82.1% of the whole reduction. The industrial share and the residual—which may partly show a technology effect—also made a significant contribution to the reduction of CO<sub>2</sub> inequality, with 39.7% and 42.8%, respectively. In contrast, we could say that CO<sub>2</sub> inequality could have decreased even more if affluence, agricultural share or non-dependent population had contributed in an opposite direction of what they did.

**Table 6. Contribution of factors to the change in inequality measured by log-variance (%)**

<b>Factors</b>	<b>1993–1999</b>	<b>1999–2007</b>	<b>1993–2007</b>
<b>Affluence</b>	<b>24.48</b>	<b>-233.27</b>	<b>-15.19</b>
<b>Sectoral Composition</b>	<b>-62.14</b>	<b>132.67</b>	<b>-1.50</b>
Agriculture GDP share	-131.79	104.81	-41.20
Industrial GDP share	69.65	27.86	39.70
<b>Population Structure</b>	<b>62.24</b>	<b>157.21</b>	<b>66.12</b>
Urban pop. Share	126.16	131.09	82.14
Non-dependent pop.	-63.92	26.12	-16.02
<b>Climate</b>	<b>7.96</b>	<b>13.61</b>	<b>7.75</b>
<b>Residual</b>	<b>67.46</b>	<b>29.78</b>	<b>42.82</b>
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b><i>Total change in log-variance</i></b>	<b><i>-9</i></b>	<b><i>-10</i></b>	<b><i>-18</i></b>

Note: The last row shows the total change in inequality for the different periods. The rest of the rows show the percentage of this change that is attributable to each factor.

Source: Produced by the authors based on World Bank (2013).

#### **4. Conclusions**

This paper contributes to the literature of the international distribution of environmental pressures and especially to the literature focused on the empirical measurement of the international inequality of CO<sub>2</sub> emissions. The analysis of the international distribution of CO<sub>2</sub> emissions per capita is of great relevance to inform the debates on climate change responsibilities, the design of future agreements and the international distribution of abatement efforts.

We have used causal components instead of the usual analytical (identity) components examined in the literature of the measurement of environmental indicators inequality. The estimation of a model of the determinants of CO<sub>2</sub> emissions per capita has enabled us to decompose the international inequality in these emissions in terms of affluence, productive structure, demographic characteristics and a climate variable showing differences in average daily minimum temperatures (variables that have often been used in STIRPAT models, and in the models employed to test the environmental Kuznets curve hypothesis, among others). We have used the RBID methodology developed by Fields (2003) which, despite being widely applied in empirical studies of income inequality, has not yet been applied to environmental issues as far as we know. The empirical application of such a method opens the door to new possibilities in the research of distributional issues of the environment–society relationship.

The empirical results contribute significantly to expanding knowledge of the factors contributing to the international disparities of CO<sub>2</sub> emissions per capita. As may be expected, 95% of such disparities are accounted for by anthropogenic driving forces (since climate control contributed only around 5%). The country's affluence factor was found as a variable contributing significantly to inequality, which means that remaining differences in GDP per capita are still avoiding greater reductions in emissions inequality. According to our results, its relative contribution, despite having increased to 20%, is not the main driving force explaining emissions per capita differences. As for demographic variables, population age distribution (measured by non-dependent population share) appears as the main contributor to the analysed inequality because of its

importance in spurring CO<sub>2</sub> emissions per capita rather than by its dispersion among countries. This factor contributed to increasing inequality of emissions per capita during the period analysed. In contrast, of the factors considered, urbanisation became the lowest contributor to international disparities in CO<sub>2</sub> emissions. The reason must be found in its lower importance in explaining emissions (coefficient effect) rather than in its dispersion. Finally, the role played by the residual may (with caution) be seen partly as the consequence of international technology spillovers, since it has contributed to narrow differences between countries in terms of emissions per capita.

The unequal use of the global sink capacity of the Earth is closely related to the difficulty of reaching consensus on how to share the burden of emissions mitigation and so appears as one of the main barriers to achieving effective international agreements on emissions control and mitigation. Moreover, the design of agreements could not be done without appropriately taking into account this unequal contribution to the problem and the reasons leading to it, if wide participation is to be achieved. The present paper contributes information on the main factors responsible for international inequalities in emissions per capita and so indicates some of the roots of the difficulties of achieving global mitigation agreements. Besides, it gives some clues to which factors could lead to a greater convergence or divergence of emissions per capita among countries over time. According to our results, some implications could be highlighted. First, it seems of great relevance to analyse the different consumption patterns associated with demographic factors and how they can change over time. Analysing in depth the different energy consumption and CO<sub>2</sub> emissions patterns associated with urbanisation and to the share of potentially active population seems of great importance to understanding emissions drivers, the differences in emissions across countries and how can they change over time and so condition the possibility of achieving agreements. These results also indicate the need to focus policies on controlling the emissions associated with these patterns. Second, the objective of economic convergence, which is a highly desirable objective by itself, would have a clear impact on reducing emissions inequality and so facilitating agreements between countries. Third, the change in emissions inequality associated with different

sectoral compositions may depend on whether future economies tend toward convergence to more similar economic structures or whether the trend is to increase international specialisation. In any case our results show that those countries more specialised in services tend to increase their differences in emissions with those specialised in agriculture, in contrast with the often-popular idea that the tertiary sector is a cleaner sector. Finally, though the residuals of our estimation may be the result of different things, they may be indicating that one of the ways in which more is to be gained is to decrease emissions differences via more effective technological diffusion.

### **Acknowledgments**

The authors acknowledge support from projects ECO2010-18158 and ECO2012-34591 (Spanish Ministry of Economy and Competitiveness), 2009SGR-600, XREPP, and XREAP (DGR).

### **References**

- Alcántara, V., Duro, J. A. (2004). Inequality of energy intensities across OECD countries: A note. *Energy Policy*, 32(11), 1257–1260.
- Alcántara, V. and Padilla, E. (2009) "Input–output subsystems and pollution: An application to the service sector and CO<sub>2</sub> emissions in Spain", *Ecological Economics*, 68 (3), 905–914.
- Aldy, J. (2006). Per capita carbon dioxide emissions: Convergence or divergence? *Environmental and Resource Economics*, 33(4), 533–555.
- Barassi, M.R., Cole, M.A., Elliott, R.J.R., 2011. The stochastic convergence of CO<sub>2</sub> emissions: a long memory approach. *Environmental and Resource Economics* 49, 367–385.
- Atkinson, A., 1970. On the measurement of inequality. *Journal of Economic Theory*. 3, 244–263.
- Cantore, N. (2011). "Distributional aspects of emissions in climate change integrated assessment models", *Energy Policy*, 39 (5), 2919–2924.

- Cantore, N., Padilla, E. (2010) "Equality and CO<sub>2</sub> emissions distribution in climate change integrated assessment modelling", *Energy*, 35 (1), 298–313.
- Cole, Neumayer, E. (2004) "Examining the Impact of Demographic Factors On Air Pollution", *Population and Environment*, 26 (1), 5–21.
- Cowell, F. (2000). Chapter 2 measurement of inequality. *Handbook of income distribution*. edited by A. B. Atkinson and F. Bourguignon (pp. 87–166) Elsevier doi:10.1016/S1574-0056(00)80005-6
- Cowell, F. (2011). *Measuring inequality* Oxford University Press.
- Criado, C. O., & Grether, J. (2010). Convergence in per capita CO<sub>2</sub> emissions: A robust distributional approach CEPE Center for Energy Policy and Economics, ETH Zürich.
- Dietz, T., Rosa, E.A. and York, R. (2007) "Driving the human ecological footprint", *Frontiers in Ecology and the Environment*, 5 (1), 13–18.
- Dinda, S. (2004). Environmental kuznets curve hypothesis: A survey. *Ecological Economics*, 49(4), 431–455.
- Duro, J. A. (2012). On the automatic application of inequality indexes in the analysis of the international distribution of environmental indicators. *Ecological Economics*, 76(0), 1–7.
- Duro, J. A., Padilla, E. (2006). International inequalities in per capita CO<sub>2</sub> emissions: A decomposition methodology by kaya factors. *Energy Economics*, 28(2), 170–187.
- Duro, J. A., Padilla, E. (2008). Analysis of the international distribution of per capita CO<sub>2</sub> emissions using the polarization concept. *Energy Policy*, 36(1), 456–466.
- Ezcurra, R. (2007). Is there cross-country convergence in carbon dioxide emissions? *Energy Policy*, 35(2), 1363–1372.
- Fields, G. S. (2003). Accounting for income inequality and its change: A new method, with application to the distribution of earnings in the United States.

- Research in Labor Economics*, 1–38.
- Fourcroy, C., Gallouj, F., and Decellas, F. (2012) “Energy consumption in service industries: Challenging the myth of non-materiality”, *Ecological Economics*, 81,155–164.
- Friedl, B., Getzner, M. (2003). Determinants of CO<sub>2</sub> emissions in a small open economy. *Ecological Economics*, 45(1), 133-148.
- Grossman, G. (1993). Pollution and growth: What do we know? C.E.P.R. Discussion Papers.
- Gujarati, D. N., Porter, D. C. (2009). *Basic econometrics* (5th ed.). Boston: McGraw-Hill.
- Gunatilaka, R., and Chotikapanich, D. (2009). Accounting for Sri Lanka's expenditure inequality 1980-2002: Regression-Dased Decomposition Approaches. *Review of Income and Wealth*, 55(4), 882–906.
- Hedenus, F., Azar, C. (2005). Estimates of trends in global income and resource inequalities. *Ecological Economics*, 55(3), 351–364.
- Heil, M. T., Wodon, Q. T. (1997). Inequality in CO<sub>2</sub> emissions between poor and rich countries. *The Journal of Environment and Development*, 6(4), 426–452.
- Heil, M. T., Wodon, Q. T. (2000). Future inequality in CO<sub>2</sub> emissions and the impact of abatement proposals. *Environmental and Resource Economics*, 17(2), 163–181.
- Jiang, L. and Hardee, K. (2011) “How do recent population trends matter to climate change”, *Population Research and Policy Review*, 30 (2), 287–312.
- Jobert, T, Karanfil, F., Tykhonenko, A., 2010, Convergence of per capita carbon dioxide emissions in the EU: legend or reality? *Energy Economics* 32, 1364–1373
- Jones, D.W. (1989) “Urbanization and energy use in economic development”, *The Energy Journal*, 10, 29–44.
- List, J., Gallet, C. (1999) “The Environmental Kuznets Curve: does one fits all?”, *Ecological Economics*, 31, pp. 409–423.

- Liu, J., Daily, G. C., Ehrlich, P., Luck, G. W. (2003) "Effects of household dynamics on resource consumption and biodiversity", *Nature*, 421, 530–533.
- Martínez-Zarzoso, I., Bengochea-Morancho, A. (2004) "Pooled mean group estimation of an environmental Kuznets curve for CO<sub>2</sub>", *Economics Letters*, 82, 121–126.
- Martinez-Zarzoso, I., Bengochea-Morancho, A. (2003) "Testing for an Environmental Kuznets Curve in latin-american countries", *Revista de Análisis Económico*, 18, 3–26.
- Morduch, J., and Sicular, T. (2002). Rethinking Inequality Decomposition with evidence from rural China. *The Economic Journal*, 112 (476), 93–106.
- Nansai, K., Kagawa, S., Suh, S., Fujii, M., Inaba, R., and Hashimoto, S. (2009) "Material and energy dependence of services and its implications for climate change", *Environmental Science and Technology*, 43, pp. 4241–4246.
- Neumayer, E. (2004) "National carbon dioxide emissions: geography matters", *Area*, 36 (1), 33–40.
- Nguyen Van, P. (2005). Distribution dynamics of CO<sub>2</sub> emissions. *Environmental and Resource Economics*, 32(4), 495–508.
- Padilla, E., Serrano, A. (2006). Inequality in CO<sub>2</sub> emissions across countries and its relationship with income inequality: A distributive approach. *Energy Policy*, 34(14), 1762–1772.
- Parikh, J. and Shukla, V. (1995) "Urbanization, energy use and greenhouse effects in economic development - results from a cross-national study of developing countries", *Global Environmental Change*, 5, 87–103.
- Perman, R., Stern, D. (1999) "The Environmental Kuznets Curve: implications of non-stationarity", The Australian National University, Centre for Resource and Environmental Studies, Working Paper in Ecological Economics N° 9901.
- Perman, R., Stern, D. (2003) "Evidence from panel unit root and cointegration test that the Environmental Kuznets Curves does not exist", *The Australian Journal of Agricultural and Resource Economics*, 47, 325–347.

- Piaggio, M., Padilla, E. (2012) "CO<sub>2</sub> Emissions and Economic Activity: heterogeneity across countries and non stationary series", *Energy Policy*, 46, 370–381.
- Romero-Ávila, D., 2008. Convergence in carbon dioxide emissions among industrialized countries revisited. *Energy Economics* 30, 2265–2282.
- Sen, A., 1973. *On Economic Inequality*. Oxford, Clarendon Press.
- Sengupta, R., Unlisted. (1996). Economic development and CO<sub>2</sub> emission: Economy-environment relation and policy approach to choice of emission standard for climate control. Boston University, Institute for Economic Development, Boston University - Institute for Economic Development.
- Sharma, S. S. (2011). Determinants of carbon dioxide emissions: Empirical evidence from 69 countries. *Applied Energy*, 88(1), 376-382.
- Shorrocks, A. F. (1982). Inequality decomposition by factor components. *Econometrica*, 50(1), 193–211.
- Shorrocks, A. F. (1983). The impact of income components on the distribution of family incomes. *The Quarterly Journal of Economics*, 98(2), 311–326.
- Stern, D. I., Common, M. S., Barbier, E. B. (1996). Economic growth and environmental degradation: The environmental Kuznets curve and sustainable development. *World Development*, 24(7), 1151–1160.
- Strazicich, M. C., List, J. A. (2003). Are CO<sub>2</sub> emission levels converging among industrial countries? *Environmental and Resource Economics*, 24(3), 263–271.
- Suh, S. (2006) "Are services better for climate change". *Environmental Science and Technology*, 40 (21), 6555–6560.
- Suri, V., & Chapman, D. (1998). Economic growth, trade and energy: Implications for the environmental kuznets curve. *Ecological Economics*, 25(2), 195–208.
- Taskin, F., Zaim, O. (2000). Searching for a kuznets curve in environmental efficiency using kernel estimation. *Economics Letters*, 68(2), 217–223.



- Torras, M., Boyce, J. K. (1998). Income, inequality, and pollution: A reassessment of the environmental kuznets curve. *Ecological Economics*, 25(2), 147–160.
- Van, P. N. (2005). Distribution dynamics of CO2 emissions THEMA (Théorie Economique, Modélisation et Applications), Université de Cergy-Pontoise.
- Wan, G. (2004). Accounting for income inequality in rural China: A regression-based approach. *Journal of Comparative Economics*, 32(2), 348–363.
- World Bank (2013). *World Development Indicators and Climate Change Knowledge Portal*. <http://data.worldbank.org/>, accessed on February, 2013.
- York, R., Rosa, E. A., Dietz, T. (2003). STIRPAT, IPAT and IMPACT: Analytic tools for unpacking the driving forces of environmental impacts. *Ecological Economics*, 46(3), 351–365.

## 2011

- 2011/1, **Oppedisano, V; Turati, G.:** "What are the causes of educational inequalities and of their evolution over time in Europe? Evidence from PISA"
- 2011/2, **Dahlberg, M; Edmark, K; Lundqvist, H.:** "Ethnic diversity and preferences for redistribution"
- 2011/3, **Canova, L.; Vaglio, A.:** "Why do educated mothers matter? A model of parental help"
- 2011/4, **Delgado, F.J.; Lago-Peñas, S.; Mayor, M.:** "On the determinants of local tax rates: new evidence from Spain"
- 2011/5, **Piolatto, A.; Schuett, F.:** "A model of music piracy with popularity-dependent copying costs"
- 2011/6, **Duch, N.; García-Estévez, J.; Parellada, M.:** "Universities and regional economic growth in Spanish regions"
- 2011/7, **Duch, N.; García-Estévez, J.:** "Do universities affect firms' location decisions? Evidence from Spain"
- 2011/8, **Dahlberg, M.; Mörk, E.:** "Is there an election cycle in public employment? Separating time effects from election year effects"
- 2011/9, **Costas-Pérez, E.; Solé-Ollé, A.; Sorribas-Navarro, P.:** "Corruption scandals, press reporting, and accountability. Evidence from Spanish mayors"
- 2011/10, **Choi, A.; Calero, J.; Escardíbul, J.O.:** "Hell to touch the sky? Private tutoring and academic achievement in Korea"
- 2011/11, **Mira Godinho, M.; Cartaxo, R.:** "University patenting, licensing and technology transfer: how organizational context and available resources determine performance"
- 2011/12, **Duch-Brown, N.; García-Quevedo, J.; Montolio, D.:** "The link between public support and private R&D effort: What is the optimal subsidy?"
- 2011/13, **Breuilé, M.L.; Duran-Vigeneron, P.; Samson, A.L.:** "To assemble to resemble? A study of tax disparities among French municipalities"
- 2011/14, **McCann, P.; Ortega-Argilés, R.:** "Smart specialisation, regional growth and applications to EU cohesion policy"
- 2011/15, **Montolio, D.; Trillas, F.:** "Regulatory federalism and industrial policy in broadband telecommunications"
- 2011/16, **Pelegrín, A.; Bolancé, C.:** "Offshoring and company characteristics: some evidence from the analysis of Spanish firm data"
- 2011/17, **Lin, C.:** "Give me your wired and your highly skilled: measuring the impact of immigration policy on employers and shareholders"
- 2011/18, **Bianchini, L.; Revelli, F.:** "Green polities: urban environmental performance and government popularity"
- 2011/19, **López Real, J.:** "Family reunification or point-based immigration system? The case of the U.S. and Mexico"
- 2011/20, **Bogliacino, F.; Piva, M.; Vivarelli, M.:** "The impact of R&D on employment in Europe: a firm-level analysis"
- 2011/21, **Tonello, M.:** "Mechanisms of peer interactions between native and non-native students: rejection or integration?"
- 2011/22, **García-Quevedo, J.; Mas-Verdú, F.; Montolio, D.:** "What type of innovative firms acquire knowledge intensive services and from which suppliers?"
- 2011/23, **Banal-Estañol, A.; Macho-Stadler, I.; Pérez-Castrillo, D.:** "Research output from university-industry collaborative projects"
- 2011/24, **Lighthart, J.E.; Van Oudheusden, P.:** "In government we trust: the role of fiscal decentralization"
- 2011/25, **Mongrain, S.; Wilson, J.D.:** "Tax competition with heterogeneous capital mobility"
- 2011/26, **Caruso, R.; Costa, J.; Ricciuti, R.:** "The probability of military rule in Africa, 1970-2007"
- 2011/27, **Solé-Ollé, A.; Viladecans-Marsal, E.:** "Local spending and the housing boom"
- 2011/28, **Simón, H.; Ramos, R.; Sanromá, E.:** "Occupational mobility of immigrants in a low skilled economy. The Spanish case"
- 2011/29, **Piolatto, A.; Trotin, G.:** "Optimal tax enforcement under prospect theory"
- 2011/30, **Montolio, D.; Piolatto, A.:** "Financing public education when altruistic agents have retirement concerns"
- 2011/31, **García-Quevedo, J.; Pellegrino, G.; Vivarelli, M.:** "The determinants of YICs' R&D activity"
- 2011/32, **Goodspeed, T.J.:** "Corruption, accountability, and decentralization: theory and evidence from Mexico"
- 2011/33, **Pedraja, F.; Cordero, J.M.:** "Analysis of alternative proposals to reform the Spanish intergovernmental transfer system for municipalities"
- 2011/34, **Jofre-Monseny, J.; Sorribas-Navarro, P.; Vázquez-Grenno, J.:** "Welfare spending and ethnic heterogeneity: evidence from a massive immigration wave"
- 2011/35, **Lyytikäinen, T.:** "Tax competition among local governments: evidence from a property tax reform in Finland"
- 2011/36, **Brühlhart, M.; Schmidheiny, K.:** "Estimating the Rivalness of State-Level Inward FDI"
- 2011/37, **García-Pérez, J.I.; Hidalgo-Hidalgo, M.; Robles-Zurita, J.A.:** "Does grade retention affect achievement? Some evidence from Pisa"
- 2011/38, **Boffa, f.; Panzar, J.:** "Bottleneck co-ownership as a regulatory alternative"

- 2011/39, **González-Val, R.; Olmo, J.:** "Growth in a cross-section of cities: location, increasing returns or random growth?"
- 2011/40, **Anesi, V.; De Donder, P.:** "Voting under the threat of secession: accommodation vs. repression"
- 2011/41, **Di Pietro, G.; Mora, T.:** "The effect of the l'Aquila earthquake on labour market outcomes"
- 2011/42, **Brueckner, J.K.; Neumark, D.:** "Beaches, sunshine, and public-sector pay: theory and evidence on amenities and rent extraction by government workers"
- 2011/43, **Cortés, D.:** "Decentralization of government and contracting with the private sector"
- 2011/44, **Turati, G.; Montolio, D.; Piacenza, M.:** "Fiscal decentralisation, private school funding, and students' achievements. A tale from two Roman catholic countries"

---

2012

---

- 2012/1, **Montolio, D.; Trujillo, E.:** "What drives investment in telecommunications? The role of regulation, firms' internationalization and market knowledge"
- 2012/2, **Giesen, K.; Suedekum, J.:** "The size distribution across all "cities": a unifying approach"
- 2012/3, **Foremny, D.; Riedel, N.:** "Business taxes and the electoral cycle"
- 2012/4, **García-Estévez, J.; Duch-Brown, N.:** "Student graduation: to what extent does university expenditure matter?"
- 2012/5, **Durán-Cabré, J.M.; Esteller-Moré, A.; Salvadori, L.:** "Empirical evidence on horizontal competition in tax enforcement"
- 2012/6, **Pickering, A.C.; Rockey, J.:** "Ideology and the growth of US state government"
- 2012/7, **Vergolini, L.; Zanini, N.:** "How does aid matter? The effect of financial aid on university enrolment decisions"
- 2012/8, **Backus, P.:** "Gibrat's law and legacy for non-profit organisations: a non-parametric analysis"
- 2012/9, **Jofre-Monseny, J.; Marín-López, R.; Viladecans-Marsal, E.:** "What underlies localization and urbanization economies? Evidence from the location of new firms"
- 2012/10, **Mantovani, A.; Vandekerckhove, J.:** "The strategic interplay between bundling and merging in complementary markets"
- 2012/11, **García-López, M.A.:** "Urban spatial structure, suburbanization and transportation in Barcelona"
- 2012/12, **Revelli, F.:** "Business taxation and economic performance in hierarchical government structures"
- 2012/13, **Arqué-Castells, P.; Mohnen, P.:** "Sunk costs, extensive R&D subsidies and permanent inducement effects"
- 2012/14, **Boffa, F.; Piolatto, A.; Ponzetto, G.:** "Centralization and accountability: theory and evidence from the Clean Air Act"
- 2012/15, **Cheshire, P.C.; Hilber, C.A.L.; Kaplanis, I.:** "Land use regulation and productivity – land matters: evidence from a UK supermarket chain"
- 2012/16, **Choi, A.; Calero, J.:** "The contribution of the disabled to the attainment of the Europe 2020 strategy headline targets"
- 2012/17, **Silva, J.I.; Vázquez-Grenno, J.:** "The ins and outs of unemployment in a two-tier labor market"
- 2012/18, **González-Val, R.; Lanaspá, L.; Sanz, F.:** "New evidence on Gibrat's law for cities"
- 2012/19, **Vázquez-Grenno, J.:** "Job search methods in times of crisis: native and immigrant strategies in Spain"
- 2012/20, **Lessmann, C.:** "Regional inequality and decentralization – an empirical analysis"
- 2012/21, **Nuevo-Chiquero, A.:** "Trends in shotgun marriages: the pill, the will or the cost?"
- 2012/22, **Piil Damm, A.:** "Neighborhood quality and labor market outcomes: evidence from quasi-random neighborhood assignment of immigrants"
- 2012/23, **Ploeckl, F.:** "Space, settlements, towns: the influence of geography and market access on settlement distribution and urbanization"
- 2012/24, **Algan, Y.; Hémet, C.; Laitin, D.:** "Diversity and local public goods: a natural experiment with exogenous residential allocation"
- 2012/25, **Martínez, D.; Sjögren, T.:** "Vertical externalities with lump-sum taxes: how much difference does unemployment make?"
- 2012/26, **Cubel, M.; Sanchez-Pages, S.:** "The effect of within-group inequality in a conflict against a unitary threat"
- 2012/27, **Andini, M.; De Blasio, G.; Duranton, G.; Strange, W.C.:** "Marshallian labor market pooling: evidence from Italy"
- 2012/28, **Solé-Ollé, A.; Viladecans-Marsal, E.:** "Do political parties matter for local land use policies?"
- 2012/29, **Buonanno, P.; Durante, R.; Prarolo, G.; Vanin, P.:** "Poor institutions, rich mines: resource curse and the origins of the Sicilian mafia"
- 2012/30, **Anghel, B.; Cabrales, A.; Carro, J.M.:** "Evaluating a bilingual education program in Spain: the impact beyond foreign language learning"
- 2012/31, **Curto-Grau, M.; Solé-Ollé, A.; Sorribas-Navarro, P.:** "Partisan targeting of inter-governmental transfers & state interference in local elections: evidence from Spain"

- 2012/32, **Kappeler, A.; Solé-Ollé, A.; Stephan, A.; Väilä, T.:** "Does fiscal decentralization foster regional investment in productive infrastructure?"
- 2012/33, **Rizzo, L.; Zanardi, A.:** "Single vs double ballot and party coalitions: the impact on fiscal policy. Evidence from Italy"
- 2012/34, **Ramachandran, R.:** "Language use in education and primary schooling attainment: evidence from a natural experiment in Ethiopia"
- 2012/35, **Rothstein, J.:** "Teacher quality policy when supply matters"
- 2012/36, **Ahlfeldt, G.M.:** "The hidden dimensions of urbanity"
- 2012/37, **Mora, T.; Gil, J.; Sicras-Mainar, A.:** "The influence of BMI, obesity and overweight on medical costs: a panel data approach"
- 2012/38, **Pelegrín, A.; García-Quevedo, J.:** "Which firms are involved in foreign vertical integration?"
- 2012/39, **Agasisti, T.; Longobardi, S.:** "Inequality in education: can Italian disadvantaged students close the gap? A focus on resilience in the Italian school system"

---

2013

---

- 2013/1, **Sánchez-Vidal, M.; González-Val, R.; Viladecans-Marsal, E.:** "Sequential city growth in the US: does age matter?"
- 2013/2, **Hortas Rico, M.:** "Sprawl, blight and the role of urban containment policies. Evidence from US cities"
- 2013/3, **Lampón, J.F.; Cabanelas-Lorenzo, P.; Lago-Peñas, S.:** "Why firms relocate their production overseas? The answer lies inside: corporate, logistic and technological determinants"
- 2013/4, **Montolio, D.; Planells, S.:** "Does tourism boost criminal activity? Evidence from a top touristic country"
- 2013/5, **García-López, M.A.; Holl, A.; Viladecans-Marsal, E.:** "Suburbanization and highways: when the Romans, the Bourbons and the first cars still shape Spanish cities"
- 2013/6, **Bosch, N.; Espasa, M.; Montolio, D.:** "Should large Spanish municipalities be financially compensated? Costs and benefits of being a capital/central municipality"
- 2013/7, **Escardíbul, J.O.; Mora, T.:** "Teacher gender and student performance in mathematics. Evidence from Catalonia"
- 2013/8, **Arqué-Castells, P.; Viladecans-Marsal, E.:** "Banking towards development: evidence from the Spanish banking expansion plan"
- 2013/9, **Asensio, J.; Gómez-Lobo, A.; Matas, A.:** "How effective are policies to reduce gasoline consumption? Evaluating a quasi-natural experiment in Spain"
- 2013/10, **Jofre-Monseny, J.:** "The effects of unemployment benefits on migration in lagging regions"
- 2013/11, **Segarra, A.; García-Quevedo, J.; Teruel, M.:** "Financial constraints and the failure of innovation projects"
- 2013/12, **Jerrim, J.; Choi, A.:** "The mathematics skills of school children: How does England compare to the high performing East Asian jurisdictions?"
- 2013/13, **González-Val, R.; Tirado-Fabregat, D.A.; Viladecans-Marsal, E.:** "Market potential and city growth: Spain 1860-1960"
- 2013/14, **Lundqvist, H.:** "Is it worth it? On the returns to holding political office"
- 2013/15, **Ahlfeldt, G.M.; Maennig, W.:** "Homevoters vs. leasevoters: a spatial analysis of airport effects"
- 2013/16, **Lampón, J.F.; Lago-Peñas, S.:** "Factors behind international relocation and changes in production geography in the European automobile components industry"
- 2013/17, **Guío, J.M.; Choi, A.:** "Evolution of the school failure risk during the 2000 decade in Spain: analysis of Pisa results with a two-level logistic model"
- 2013/18, **Dahlby, B.; Rodden, J.:** "A political economy model of the vertical fiscal gap and vertical fiscal imbalances in a federation"
- 2013/19, **Acacia, F.; Cubel, M.:** "Strategic voting and happiness"
- 2013/20, **Hellerstein, J.K.; Kutzbach, M.J.; Neumark, D.:** "Do labor market networks have an important spatial dimension?"
- 2013/21, **Pellegrino, G.; Savona, M.:** "Is money all? Financing versus knowledge and demand constraints to innovation"
- 2013/22, **Lin, J.:** "Regional resilience"
- 2013/23, **Costa-Campi, M.T.; Duch-Brown, N.; García-Quevedo, J.:** "R&D drivers and obstacles to innovation in the energy industry"
- 2013/24, **Huisman, R.; Stradnic, V.; Westgaard, S.:** "Renewable energy and electricity prices: indirect empirical evidence from hydro power"
- 2013/25, **Dargaud, E.; Mantovani, A.; Reggiani, C.:** "The fight against cartels: a transatlantic perspective"
- 2013/26, **Lambertini, L.; Mantovani, A.:** "Feedback equilibria in a dynamic renewable resource oligopoly: pre-emption, voracity and exhaustion"

- 2013/27, Feld, L.P.; Kalb, A.; Moessinger, M.D.; Osterloh, S.: "Sovereign bond market reactions to fiscal rules and no-bailout clauses – the Swiss experience"
- 2013/28, Hilber, C.A.L.; Vermeulen, W.: "The impact of supply constraints on house prices in England"
- 2013/29, Revelli, F.: "Tax limits and local democracy"
- 2013/30, Wang, R.; Wang, W.: "Dress-up contest: a dark side of fiscal decentralization"
- 2013/31, Dargaud, E.; Mantovani, A.; Reggiani, C.: "The fight against cartels: a transatlantic perspective"
- 2013/32, Saarimaa, T.; Tukiainen, J.: "Local representation and strategic voting: evidence from electoral boundary reforms"
- 2013/33, Agasisti, T.; Murtinu, S.: "Are we wasting public money? No! The effects of grants on Italian university students' performances"
- 2013/34, Flacher, D.; Harari-Kermadec, H.; Moulin, L.: "Financing higher education: a contributory scheme"
- 2013/35, Carozzi, F.; Repetto, L.: "Sending the pork home: birth town bias in transfers to Italian municipalities"
- 2013/36, Coad, A.; Frankish, J.S.; Roberts, R.G.; Storey, D.J.: "New venture survival and growth: Does the fog lift?"
- 2013/37, Giulietti, M.; Grossi, L.; Waterson, M.: "Revenues from storage in a competitive electricity market: Empirical evidence from Great Britain"

---

2014

---

- 2014/1, Montolio, D.; Planells-Struse, S.: "When police patrols matter. The effect of police proximity on citizens' crime risk perception"
- 2014/2, García-López, M.A.; Solé-Ollé, A.; Viladecans-Marsal, E.: "Do land use policies follow road construction?"
- 2014/3, Piolatto, A.; Rablen, M.D.: "Prospect theory and tax evasion: a reconsideration of the Yitzhaki puzzle"
- 2014/4, Cuberes, D.; González-Val, R.: "The effect of the Spanish Reconquest on Iberian Cities"
- 2014/5, Durán-Cabré, J.M.; Esteller-Moré, E.: "Tax professionals' view of the Spanish tax system: efficiency, equity and tax planning"
- 2014/6, Cubel, M.; Sanchez-Pages, S.: "Difference-form group contests"
- 2014/7, Del Rey, E.; Racionero, M.: "Choosing the type of income-contingent loan: risk-sharing versus risk-pooling"
- 2014/8, Torregrosa Hetland, S.: "A fiscal revolution? Progressivity in the Spanish tax system, 1960-1990"
- 2014/9, Piolatto, A.: "Itemised deductions: a device to reduce tax evasion"
- 2014/10, Costa, M.T.; García-Quevedo, J.; Segarra, A.: "Energy efficiency determinants: an empirical analysis of Spanish innovative firms"
- 2014/11, García-Quevedo, J.; Pellegrino, G.; Savona, M.: "Reviving demand-pull perspectives: the effect of demand uncertainty and stagnancy on R&D strategy"
- 2014/12, Calero, J.; Escardíbul, J.O.: "Barriers to non-formal professional training in Spain in periods of economic growth and crisis. An analysis with special attention to the effect of the previous human capital of workers"
- 2014/13, Cubel, M.; Sanchez-Pages, S.: "Gender differences and stereotypes in the beauty"
- 2014/14, Piolatto, A.; Schuett, F.: "Media competition and electoral politics"
- 2014/15, Montolio, D.; Trillas, F.; Trujillo-Baute, E.: "Regulatory environment and firm performance in EU telecommunications services"
- 2014/16, Lopez-Rodriguez, J.; Martinez, D.: "Beyond the R&D effects on innovation: the contribution of non-R&D activities to TFP growth in the EU"
- 2014/17, González-Val, R.: "Cross-sectional growth in US cities from 1990 to 2000"
- 2014/18, Vona, F.; Nicolli, F.: "Energy market liberalization and renewable energy policies in OECD countries"
- 2014/19, Curto-Grau, M.: "Voters' responsiveness to public employment policies"

